SHORT REPORT

Obtaining pulse oximetry data in neonates: a randomised crossover study of sensor application techniques

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Pulse oximetry may be useful during neonatal resuscitation. A randomised crossover study was performed to determine the most efficient method of applying the sensor. Applying it to the infant before connecting to the oximeter resulted in quickest acquisition of accurate heart rate. This technique should be preferred during resuscitation.

The need for and response to neonatal resuscitation is determined clinically.[1] Auscultation and palpation of heart rate (HR) are subjective, intermittent, and of questionable accuracy.[2 3] Assessment of colour (a proxy for oxygen saturation, Spo_2) is subjective. Pulse oximetry, routinely used in intensive care, gives continuous, accurate measures of HR and Spo_2. Although not routinely used during neonatal resuscitation, it is potentially useful in determining HR. Also, although debate continues about whether air or oxygen should be used, a role for oximetry in titrating oxygen concentrations during resuscitation has been suggested.[4] Difficulties in obtaining oximetry data during resuscitation have been reported.[5] Newer generation oximeters are more reliable than others in intensive care.[6]

After patient sensor application, a delay in obtaining data ensues while the oximeter recognises the pulse waveform and calculates HR and Spo_2; both values are then displayed simultaneously. During resuscitation, HR is of primary importance in determining need for intervention—for example, intubation, chest compressions. Thus prompt acquisition of accurate HR is ideal. The sensor can be applied in a number of ways. We sought to determine which resulted in the quickest display of accurate HR.

METHODS

We conducted a randomised crossover study of infants in our intensive and special care nurseries. All were stable and monitored with oximetry and electrocardiography (ECG). Measurements were taken in the supine position via a sensor applied to the right wrist (infants <1500 g) or palm (>1500 g). The sensor was secured using Coban wrap (3M Health Care, St Paul, Minnesota, USA).

We studied the Masimo Radical (Masimo Corporation, Irvine, California, USA) oximeter (fig 1, A), using an averaging interval of two seconds with maximal sensitivity. This oximeter has a patient cable (B) to which the sensor (C) is attached. The manufacturers recommend connecting the sensor to the cable and to the patient before switching the oximeter on. We wished to avoid the delay incurred switching on the machine. Thus, with the machine switched on, we applied the LNOP Neo-L sensor to each infant on three occasions using the following methods:

(1) sensor connected to cable, then applied to infant;
(2) sensor connected to cable, applied to investigator's finger, then to infant;
(3) sensor applied to infant, then connected to cable.

The investigator applying the sensor and the order of these methods were allocated randomly. The times taken to apply the sensor, to display data, and to display accurate HR—that is, that matched the ECG—were recorded with a stopwatch. The number of accurate first displayed HRs for each method was noted. Data were analysed using SPSS. Means were compared using paired *t* tests.

RESULTS

We studied 40 babies of various weight (mean (SD) 1659 (991) g), gestational age (29 (4.8) weeks) and postnatal age (22 (31) days).

The time taken to apply the sensor using method 3 compared with method 1 was slightly longer but this was not significant (table 1). The time taken by the oximeter to display the correct HR using method 3 was significantly shorter (mean (SD) difference 10 (20) seconds, $p = 0.004$) (table 1). Combining these time periods gave the time for accurate HR data to be displayed. The quickest method was 3, followed by 2, then 1. The difference between methods 1 and 3 was significant (mean (SD) difference 7 (20) seconds, $p = 0.047$); the difference between methods 2 and 3 was not. The proportion of accurate first displayed HRs was 80%, 28%, and 93% for methods 1, 2, and 3 respectively. Thus method 3 gave the quickest, most accurate HR data.

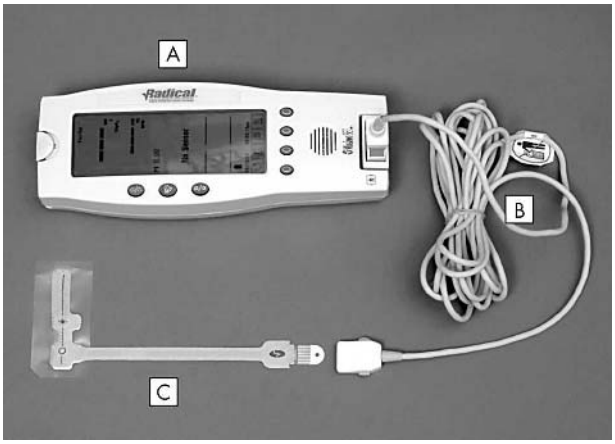

Figure 1 Masimo Radical pulse oximeter (A) with patient cable (B) and sensor (C).

Abbreviations: ECG, electrocardiography; HR, heart rate; Spo_2, oxygen saturation

Table 1 Time taken to apply the sensor and display data for each method of application

	Method 1	Method 2	Method 3
Time to apply sensor (s)	9 (2)	10 (2)	12 (2)
Time to display accurate HR from sensor application (s)	23 (20)	18 (17)	13 (7)
Total time to display accurate HR data (s)	32 (21)	28 (17)	25 (7)

Values are mean (SD). Method 1, sensor connected to oximeter, then to neonate; method 2, sensor connected to oximeter, applied to investigator's finger, then to neonate; method 3, sensor applied to neonate, then connected to oximeter.
HR, Heart rate.

DISCUSSION

This study does not specifically address the question of which method of sensor application most rapidly obtains an accurate Spo_2. We believe that HR monitoring is more important than Spo_2 in effectively guiding neonatal resuscitation; thus it was the focus of this study.

An oximeter switched on with the sensor connected will immediately try to calculate data. If the sensor is not applied to a person, the oximeter tries to interpret environmental stimuli and may generate artificial signal. This delays the display of data when the sensor is subsequently applied to an infant (method 1). When the sensor is first applied to an investigator (method 2), data are acquired more quickly. Data from the investigator are initially averaged, however, and this often leads to the display of an erroneous initial HR. The subsequent delay in displaying the correct HR is variable (mean (SD) 9 (7) seconds here). The display of incorrect HR during resuscitation is concerning as it may prompt inappropriate intervention or inaction; thus, in the absence of an ECG to assess accuracy of the oximeter HR, we advise against using method 2.

A seven second difference in obtaining data, although not large, may be clinically important during resuscitation. This study assessed stable infants who were not being resuscitated. It is possible that it may take longer to apply a sensor and obtain data during delivery room resuscitation. The algorithms used by the oximeter, however, do not change. The differences observed may thus become greater and more clinically important.

We assessed the Masimo Radical oximeter; this study should be repeated for other oximeters to confirm the superiority of this method of sensor application.

CONCLUSION

In intensive and special care settings, applying the sensor to the right hand or wrist before connection to the pulse oximeter results in quicker acquisition of accurate HR data in infants compared with other techniques. This method of application should be preferred during resuscitation.

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